LS-78
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General Specifications of the Infield Buildings of the Advanced Photon Source

This LS note is the result of a series of meetings, conversations and private decisions made during December 1986 and January 1987. Its purpose is to document in one place all design decisions and rationale concerning the several infield buildings of the APS. While most of the data below are independent of lattice choice, the operative lattice at this time is the 40-sector CGA using a circumference of 1,060 meters

Although intended to cover all infield structures, this note does not address such details as the storage ring entrance mazes or transformer pads since these are, more appropriately, part of the storage ring building specifications. The vehicular access tunnel and infield road layout are likewise not addressed.

In all cast concrete structures such as the linac and synchrotron tunnels Unistrut is to be cast into all exposed surfaces to allow convenient attachment points. The Unistrut would be at right angles to the tunnel centerline on both walls and ceiling at about 6-foot intervals. Some walls, such as those common to two occupied areas, would have this feature on both sides of the wall.

Since the items which follow cover a great variety of subjects, no attempt was made to categorize the information except by building.

Portions of sketches submitted to the AE in January, 1987 are reproduced here as Figs. 1 through 5. Most of the text will be easier to understand if the figures are referenced.

RF Buildings (See Fig. 1)

These buildings, referred to as RF/Power buildings and Utility buildings are referred to here simply as RF buildings. They are to be distributed uniformly around the inner wall of the storage ring building and will serve to house the storage ring RF equipment and to support the storage ring components in the area of AC and DC power, emergency generators, and cooling water booster pumps.

1) There will be only two RF/Power buildings in the infield area. Consolidating all RF equipment in two buildings (see next item) will save money compared to the three- or four-building options.

2) Each building will include space for two complete RF/waveguide systems and their accompanying power supplies.

3) Two adjacent ID regions will be used for RF cavities in areas 180 degrees apart in the storage ring.

4) The storage ring dipole power supply and its regulator will be located in one of these buildings. The regulator will include a dipole magnet to act as a reference magnet for precision field measurements to control the regulator.

5) The third-harmonic RF system is to be considered small enough to fit into available space in either building. One possibility would be to locate this equipment in the RF building which does not contain the dipole power supply in space vacated by that supply.

6) There will be very minimal sanitary facilities in both buildings including a small unisex washroom. (More extensive facilities including lockers and showers will be provided in the Synchrotron Injection building.)

7) These buildings will continue to have only heat and ventilation provision.

8) There will be an air-conditioned room within the building to accommodate the control system, low-level RF electronics and, in one of the two buildings, the dipole power supply regulator and extra reference dipole magnet. This room will be located against the storage ring side of the building.

9) The floor level of these buildings is assumed to be the same as that of the storage ring building. If vertical siting of the storage ring building would demand that the RF building be depressed below grade, a vertical translation of the RF waveguides will be investigated to avoid this associated cost and retain ground-level truck access. Regardless of vertical siting, truck access at the floor level must be provided.

10) There will be a rear (storage ring side) exit leading to an entrance to the storage ring. This entrance is to be at the top-of-shield level in the storage ring, so a stairway will be needed either within this RF building or just outside. This passage need not be covered, but a covered passage would be preferred. Provision must be made to accommodate signal cables and, in the case of the dipole power supply area, dipole current cabling to go from the RF building to the storage ring building. This pedestrian passage could be made wide enough to accommodate these cable trays. A storage ring tunnel access maze may be deliberately located here and these entrances would be combined.

11) The separation between this building and the storage ring building can be anything from zero to five feet. If a non-zero spacing is used, a covering should be provided for the two RF waveguide passages. This enclosed volume should be made a part of the RF building's air space.

12) Regardless of the interbuilding spacing, adequate shielding must be provided on the infield side of the storage ring tunnel. For instance, if earth shielding is used to supplement a thinner concrete wall the full thickness concrete wall must be used in this area since there will not be room for an earth berm.

13) A transformer pad will be located outside the building and space for AC switchgear will be provided within the building. This transformer and switchgear equipment will, in general, serve one half of the AC power needs of the storage ring components in addition to those in the RF building itself.

14) An area for cooling water circulation pumps and emergency generators will be provided within the building. This equipment will have the same service area described in item 13.

15) There will be no crane coverage in either RF building. If klystron disassembly is desired, it will be accommodated elsewhere on the ANL site.

16) Roof support will be by columns on 30-foot centers.

17) The resulting building size is about 90-feet deep (in the radial direction) by 120-feet (in the beam direction) by 16-feet high.

Linac Building (See Fig. 2)

The linac building houses the electron gun, electron linac, positron target, positron linac, the first portion of the positron beam transport line to the synchrotron and all support equipment for these components including a "klystron gallery" along one side of the building.

1) The cross section of the linac tunnel is the same as the CDR, 9 feet x 9 feet inside with walls and roof 2-meters thick concrete.

2) The 5-meter region near the positron target will have an effective concrete thickness of 2.5 meters, accomplished either by an extra 0.5 meters of concrete, use of heavy concrete, or use of steel. (If steel is used, it should be nearest the radiation source, namely within the inside surfaces of the shield wall.)

3) If an increased concrete thickness is to be used for the target region, it is to be applied on the outside, leaving a uniform cross-section space inside.

4) Removable shielding blocks are to be used to close the gun end of the tunnel in order to allow future expansion at that end. The tunnel and maze roof will be of cast concrete, however since no crane coverage is provided. The end and maze block will be rigged into place.

5) Removable shielding blocks are to be used to enclose the high energy beam transfer area. This will allow linac tank sections to be brought in during construction through this (block-free, initially) region. This means that no large entrance maze or door is needed for component entry. These blocks are actually located in the synchrotron injection building. The roof is again, cast concrete.

6) The first 11 meters of the high energy beam transfer line are within the linac building. The remainder of this beam line is contained within the injection building.

7) The building length breakdown now reads as follows:

Gun region............	10 meters	(end blocks included)
Electron linac........	20 meters	
Target region.........	2 meters	(5 meters in this area has extra shielding)
Positron linac........	40 meters	
Beam line to first BM.	11 meters	
Total:	83 meters	(Total building length)

8) The building width breakdown now reads as follows:

Klystron gallery.......	6 meters	
Near shield wall.......	2 meters	
Linac tunnel (9 feet)..	2.7 meters	
Far shield wall.......	2 meters	(less if earth berm used)
Total:	12.7 meters	(often referred to as 13 meters)

9) Building height is to be 5-meters clear in all areas outside the tunnel.

10) Two roof options will be given to the EA

A) Gable roof over both linac tunnel shield and klystron area.

B) Half-gable roof over klystron area only with waterproof cover applied to concrete shield.

11) Crane coverage has been eliminated in the klystron area. The rationale is that klystrons and all other heavy equipment can be moved on rollers and rigged into position.

12) The control room is now located in the synchrotron injection building near the high energy end of the linac

13) Space need details are still needed for the klystron area, but is seems apparent that the 6-meter area outside the tunnel will be adequate.

14) Only one access maze will be provided, at the gun end. Access to the high energy end will be through a sliding block door near the high energy end. Sliding block doors are to be used in at least three other locations in the injection complex and were chosen over mazes because of their smaller space needs, lower concrete cost, and superior shielding characteristics. There may not be a space problem in this area and a maze could be used to give faster access to the linac tunnel.

15) The shield wall opposite the klystron area may be less than 2-meters thick if earth shielding can be built up outside.

16) Sanitary facilities are not included, they will be provided in the synchrotron injection building.

17) The linac is to be mounted on the side of the tunnel away from the klystron side. This will make personnel entry, which is from the klystron side, easier.

18) The linac centerline is to be 2.5 feet from the far wall, giving about 2 feet of working space for a 12-inch diameter structure. This will leave 6.5 feet from the linac centerline to the near wall (klystron side) for personnel and servicing. The linac centerline is to be 1.5 meters above the floor.

19) The linac building will include caged areas for storage and lab areas to be specified after equipment is laid out

20) There will be transformer pad areas as needed along the outside on the klystron side of the building.

21) The klystron gallery space will not be air-conditioned but will have heating and ventilation only.

22) The linac tunnel will be air-conditioned using the same method to be used for the storage ring and synchrotron tunnels.

Synchrotron Injection Building (See Fig. 3)

This building houses the final portion of the linac-synchrotron beam transfer line, all power supplies for that beam transfer line, both synchrotron RF systems, all power supplies for the synchrotron itself, a control room, lockers and showers to serve the infield maintenance staff, and various lab and office spaces will be more firmly defined later. This building will be used as a staging area for the linac and synchrotron components. This building is sometimes referred to simply as the "Injection Building."

1) The building will house one RF waveguide/klystron and power supply system similar to that in the RF/Power buildings. Specific components have been eliminated which shorten the footprint by 4 meters. The klystron may be used in a position which is 90 degrees from the waveguide centerline if needed.

2) The above RF system will feed RF power to the opposite side of the synchrotron (to the synchrotron extraction building) via the personnel tunnel using one waveguide with a splitter at that end.

3) A low-power-level, low-frequency RF system will also be housed in this building.

4) All synchrotron magnet power supplies will be housed in this building.

5) Most (if not all) diagnostic electronics for the synchrotron and the linac injection beam line will be housed in this building.

6) All beam line and synchrotron shielding in this building will be provided by cast concrete except for enclosing blocks in the beam transfer area. This will allow linac structures to be installed in the linac tunnel and accelerator components in the ring tunnel. In the future these blocks can be reformed to allow a beam to be brought out for other uses. The roofs of the shielded area are cast concrete. The synchrotron shielding referred to is actually part of the synchrotron tunnel itself and includes a sliding block access door giving access between the injection and synchrotron buildings.

9) An air-conditioned electronics room will be provided to accommodate the control system, RF electronics, diagnostic electronics, and vacuum control electronics. A size of 10 by 10 feet should be sufficient.

10) An air-conditioned control room will be provided and will include a control console for control of the linac and synchrotron. A size of 25 by 25 feet is more than needed initially, but will allow its use in the future to serve the test beam area referred to below in item 21.

11) Space will be allowed for two or more labs and two or more offices adjacent to and above the control room area (also air-conditioned).

12) A hatch giving access to the pedestrian tunnel will be provided. The size will be large enough to pass the largest waveguide sections to be installed to feed RF power to the extraction side (about 15 feet).

13) An injection septum power supply will be housed in this building.

14) A locker and washroom area (both sexes) will be provided. The most likely location will be above the control room and lab area to save floor space.

15) The personnel tunnel which passes under this building and ends at a stairway and elevator near the control room has a branch tunnel to the RF waveguide area to allow RF power to be transported from there to the main tunnel and then to the extraction side cavities.

16) An elevator will serve the personnel tunnel, main floor and locker rooms and labs above the control room.

17) No crane coverage is provided, just the trolley hoist over the tunnel hatch.

18) Roof support will be by columns on 30-foot centers.

19) Except for the spaces detailed above, this building will have heating and ventilation only.

20) The overall dimensions decided upon are 82-feet deep by 164-feet wide (about 25 by 50 meters). The height will be enough to accommodate the two-story control room/rest room structure. This same height should be enough for the various accelerator components and roof-hung cable trays and utilities to be provided in the building.

21) The floor area near the injection beam line will be left clear as much as possible to accommodate future test beam development. The roof support beams on 30-foot centers are not considered an impediment to this development.

22) A transformer pad area outside and space for switchgear will be provided for. This equipment will serve the injection building components and by extension, the synchrotron also (except for those components located in the extraction building).

23) A 14 by 14 foot overhead door will be provided.

24) Since the synchrotron and linac beams are at the same elevation as the storage ring beam, the floor levels of all of these buildings is also the same. If vertical siting of this building and the linac building call for them to be somewhat below grade, a truck access ramp and door will be needed at the main floor level.

Synchrotron Extraction Building (See Figs. 4 and 5)

This building is located in the infield area of the synchrotron and houses the synchrotron extraction component power supplies, an RF waveguide and phase shifter, and power supplies for the synchrotron-to-storage ring beam transfer line. This building is sometimes referred to simply as the "Extraction Building."

1) This building may disappear as a separate entity and become part of the synchrotron accelerator building. It has a common wall, and depending on the final elevation, may have all of its walls made of cast concrete, making it more like a room of the synchrotron tunnel structure. Nevertheless, it will have to be constructed at the same time as the synchrotron tunnel.

2) A sliding block door giving access to the synchrotron tunnel is provided. Occupancy of this building is to be allowed during synchrotron operation.

3) The extraction beam transfer line has two bending magnets. The first bending magnet is also used to send the extracted beam to a beam stop along a diagnostic beam line which also serves as an energy spectrometer. This beam stop will be removable to allow beam to be transported to a test beam area in the future.

4) The area enclosed by the storage ring outer shield wall and the synchrotron inner shield wall will house this beam transfer line as well as the extraction kicker and drive system. The storage ring outer shield wall changes from 1.5-meter thick concrete to 0.5-meter steel (and possibly 10 centimeters of polyethylene) in the vicinity of the beam transfer line to allow sufficient space for beam line components. (This shielding thickness and material have yet to be approved by the radiation safety committee.) Occupancy of this area is to be allowed during storage ring operation.

5) A sliding block door will give access between this beam transfer area and the storage ring tunnel (this door would actually be part of the storage ring specifications).

6) The side walls (east & west) will probably be concrete retaining walls to hold back the earth shielding which covers the synchrotron tunnel (if this method is used). The height will have to equal the top of this earth shielding. The remaining (south) wall can be metal construction unless the synchrotron tunnel is cut into existing grade, in which case this wall becomes a retaining wall as well.

7) Access is via a stairwell and elevator to the pedestrian tunnel. A hatch is provided to move large equipment into the building from this pedestrian tunnel which passes directly beneath on its way from the central lab-office building to the synchrotron injection building. The elevator is being provided under the assumption that handicapped access will be required.

8) A motorized hoist riding on a linear beam (trolley) covers the hatch and a portion of the building area to the east and west.

9) If the building is cut into the existing grade making all walls concrete retaining walls (see item 6), a stairway exit via the roof may be required.

(A ladder access to the roof or an outside stairway would otherwise be provided.)

10) The equipment to be located here consists of low-level controls for the extraction kicker, high voltage power supply for the kicker, power supply and controls for the extraction septum magnets (both AC and DC), power supplies for the beam transfer line, control system racks, diagnostic electronics racks, waveguides to bring RF power from the pedestrian tunnel to the cavities and low-level RF electronics equipment.

11) RF power is brought to the cavities at ceiling level through the shield wall in the same manner planned for the storage ring.

12) An air-conditioned electronics room is provided. All other spaces have heating and ventilation only.

13) A small unisex rest room is provided.

14) No crane coverage is provided aside from the trolley of item 8.

15) Roof support is by means of columns on 30-foot centers.

16) The dimensions decided upon are 49-feet deep (radial direction) by 131-feet wide (beam direction) or 15 by 40 meters. A height of 16 feet will be assumed for the time being, but is probably more than needed.

17) Transformer pads are provided on each side (to the east and west) of the building and space for switchgear provided inside. The transformers and switchgear will serve this building, but the transformer pads will also serve the storage ring AC distribution system. (AC transformer sites are required at every other ID area, or at 20 locations around the ring. It is felt that the synchrotron tunnel will obscure too much of the inner ring wall and so these two sites within the synchrotron infield are considered necessary for transformer siting.) An extension to these pads to the south-east and south-west will allow crane delivery of a fork-lift truck and initial or replacement transformers from points outside the synchrotron tunnel structure.

18) The decision was made to locate the storage ring injection bumper power supply and support equipment in the storage ring building directly above the injection straight section (on top of the storage ring tunnel). This will minimize the lead lengths to these magnets and locate the equipment in an area which, it is felt, can provide the space.

19) A "second floor" gallery-type room will be located above this building. It will provide means to pass cable trays and personnel from the extraction building to the storage ring building. It will extend from the stairway to the north, over the beam transfer area, and into the storage ring building at the top-of-tunnel level. The width can be the same as the underground tunnel (9 feet plus room for cable trays).

Synchrotron Building (No figure, see Parts of 3, 4, and 5)

This building is actually a concrete tunnel which follows the centerline of the booster synchrotron lattice. It interfaces to the storage ring building in the extracted beam transfer area, the synchrotron extraction building in this same area, and the synchrotron injection building in the injected beam transfer area. This building is sometimes referred to simply as the "Synchrotron Tunnel."

1) The plan layout of this building (tunnel) is to match, by and large, the synchrotron lattice with the machine centerline located 3.5 feet from the inner wall and 5.5 feet from the outer wall. This will produce a 9-foot wide tunnel. The tunnel height is also to be 9 feet.

2) The tunnel walls and roof are to be 1.5 meters of concrete. If earth covering is used, this thickness can be reduced until shielding equivalent to 1.5 meters of concrete is produced. The possibility exists that the round portions of this tunnel could be made from pre-cast concrete sections and joined to poured-in-place sections near the injection and extraction areas. This will be an economic decision based on comparative costs, but is would seem to be unlikely that there are enough sections needed to warrant a custom casting effort.

3) The machine is being placed against the inner wall to allow easy access from the injection building since this will be the staging area for synchrotron components.

4) The sketch submitted to the AE shows the inner wall pulled away from the machine centerline in the vicinity of the extraction building to allow easy access from this (infield) building. This wall, common to both the extraction building and the synchrotron tunnel, is then straight in the vicinity of the extraction-side straight sections instead of curving to follow the machine centerline.

5) The synchrotron tunnel outer wall is connected to the storage ring tunnel outer wall in the vicinity of the extraction building. This will save on concrete walls while adding roof concrete to the total. An extracted beam transfer area is formed by this wall layout. We realize that the storage ring outer skin will have to follow this intrusion into the storage ring tunnel structure.

6) The extraction kicker and its high-noise support equipment is located in this beam transfer area.

7) The tunnel area is air-conditioned using the same type of equipment as in the storage ring tunnel.

8) Sliding block doors are provided giving access to the extraction and injection bulidings. (These are described in the specifications of the respective buildings.)

9) A pedestrian tunnel passes under the synchrotron building, running parallel to the minor diameter of the machine. This tunnel carries cable trays, RF

waveguide, utilities, and has a 9 by 9 foot clear space for personnel and heavy equipment movement.

10) Movable block walls form part of the injection area shielding and are removed to allow installation and replacement of synchrotron components.

11) No crane coverage is provided in the tunnel. Magnet installation is to be by means of a special magnet-carrying transporter system.

12) No other access to the outside world is provided aside from that described above to the injection and extraction buildings.

13) Penetrations through the tunnel walls for RF waveguides, magnet power and other electrical systems will be by minimum cross-section holes near the top of the tunnel as was approved for the RF penetrations for the storage ring tunnel.

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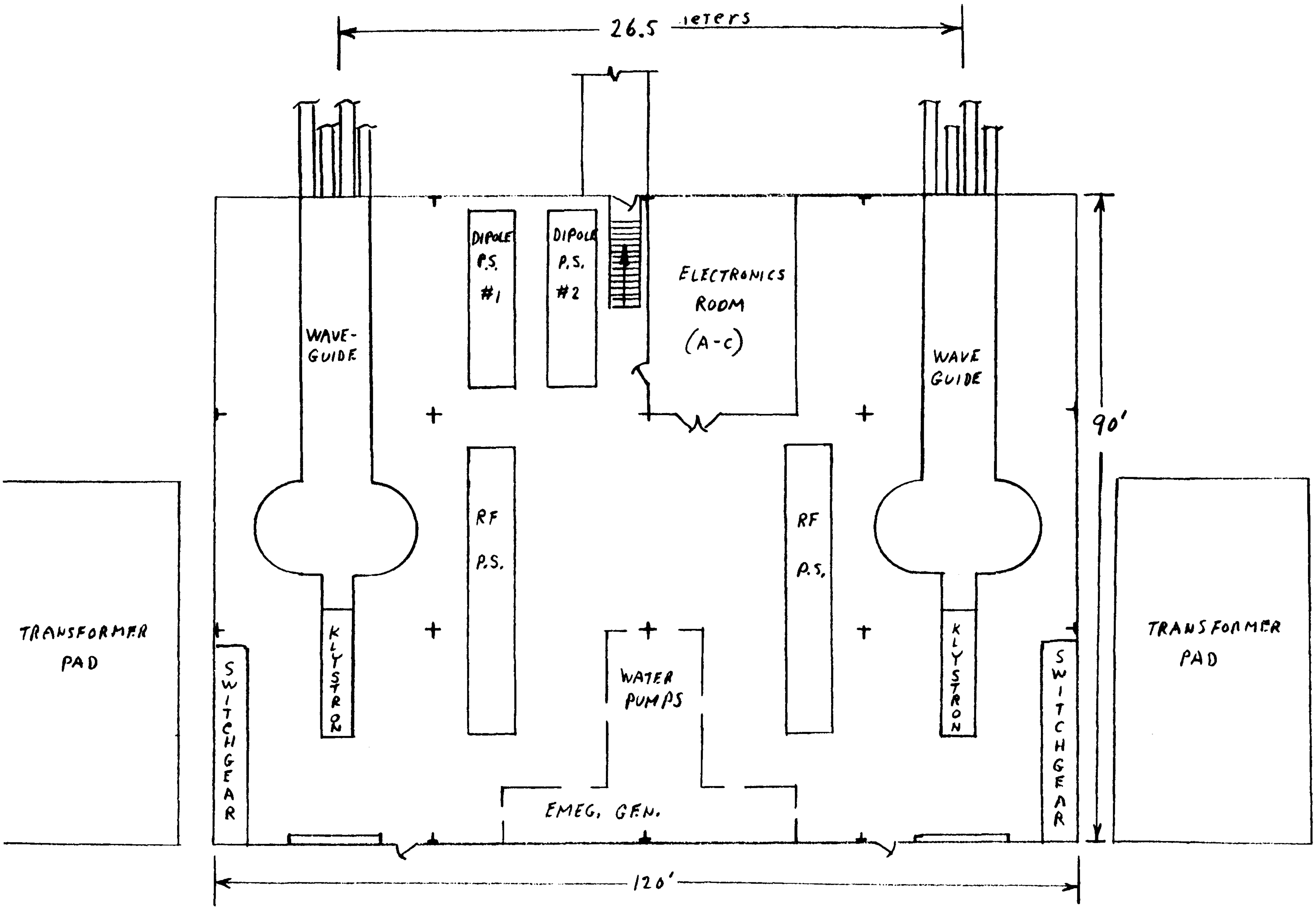
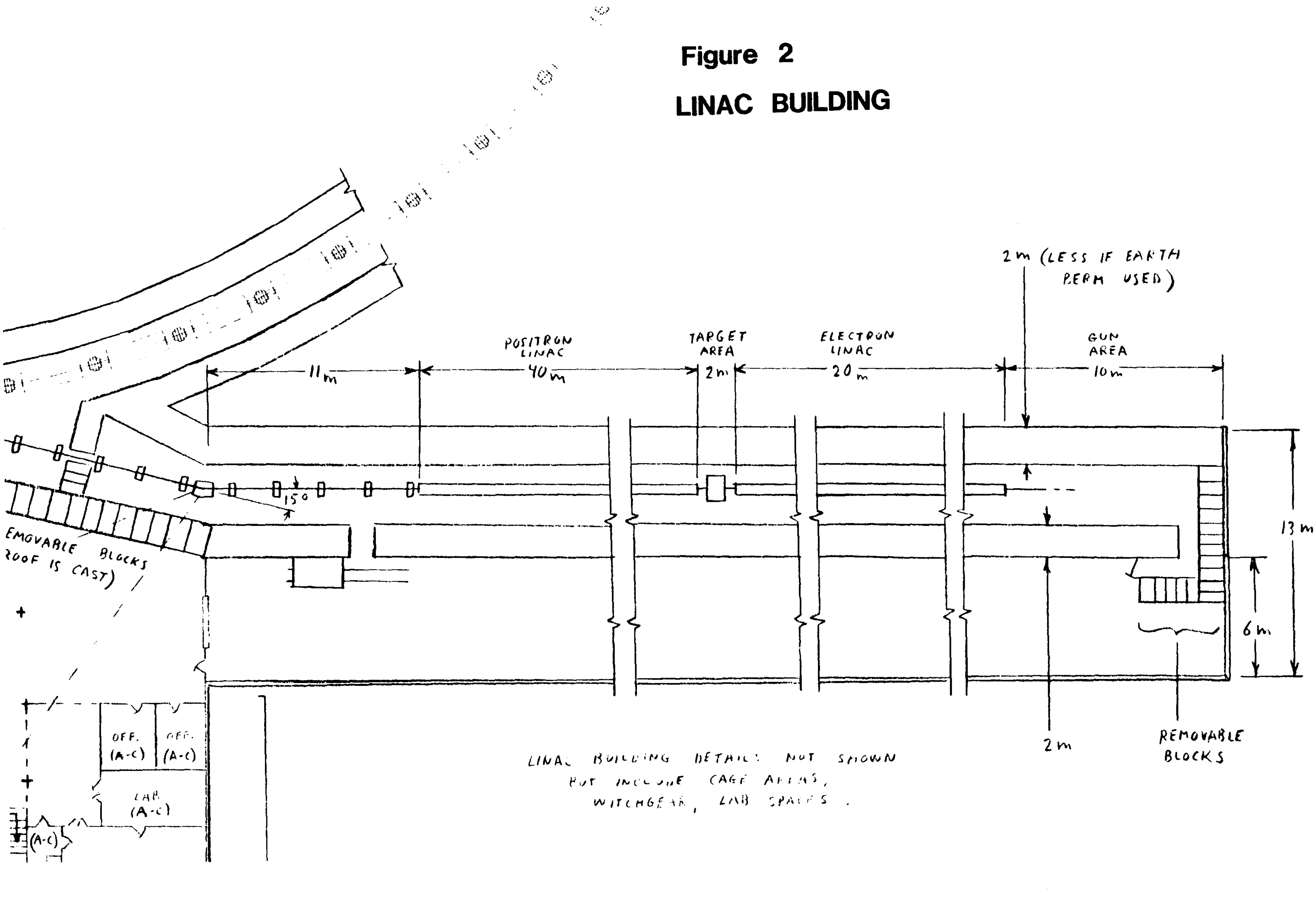


Figure 1 RF/POWER BUILDING

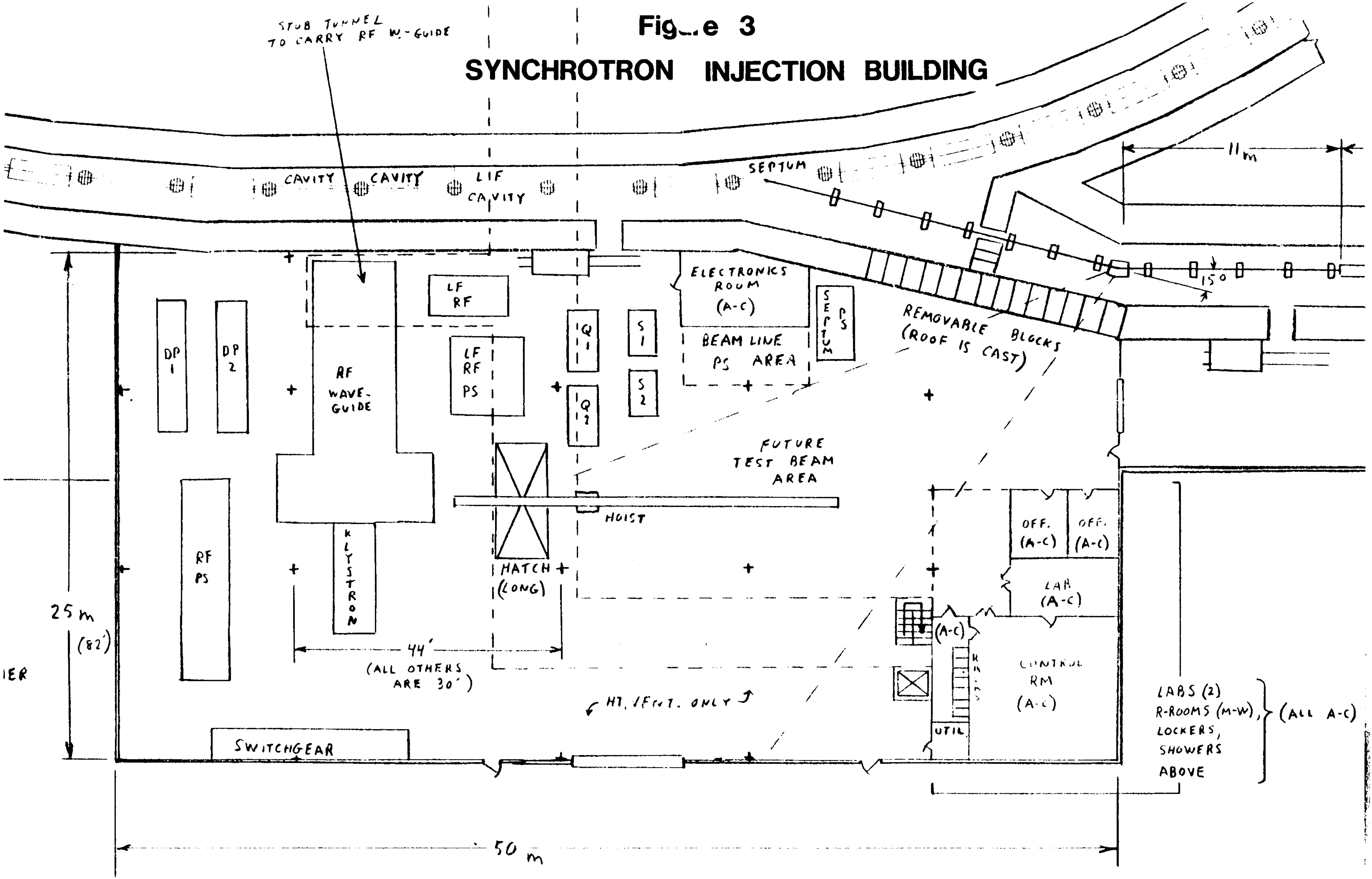
Figure 2

LINAC BUILDING



Fig_e 3

SYNCHROTRON INJECTION BUILDING



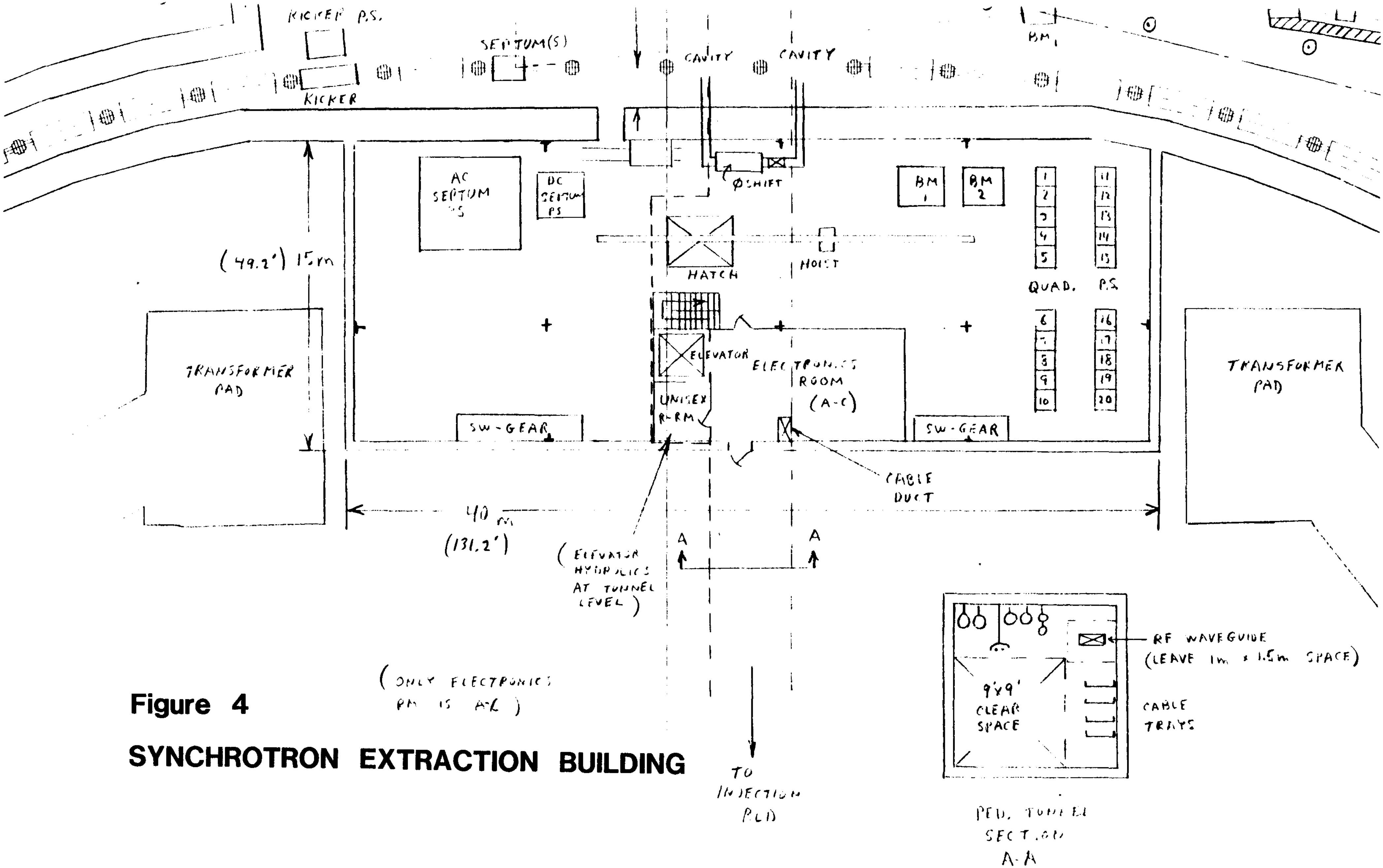


Figure 4

SYNCHROTRON EXTRACTION BUILDING

.igure 5

SYNCHROTRON EXTRACTION BUILDING